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Calotes nigrilabris Peters, 1860 (Reptilia: Agamidae: Draconinae): a threatened highland agamid lizard in Sri Lanka

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Abstract.—Calotes nigrilabris **Peters, 1860 is an endemic arboreal agamid lizard species that is found only in montane and submontane cloud forests above 1,400 m elevation in central highlands of Sri Lanka. Here we redescribe this species based on the holotype, newly collected material, and published literature. Observations on the ecology, natural history, reproduction, and behavior of *C. nigrilabris* are noted. Two specimens of *C. nigrilabris* were recorded from Thangappuwa (~1000 m a.s.l.) in the Knuckles massif in 2003 and may represent a differentiated population needing further study. Current habitat destruction and pesticide use in local farming practices are suggested as primary threats to this species. A key to identifying members of the genus *Calotes* in Sri Lanka is provided.**

Key words. Behavior, *Calotes nigrilabris*, conservation, ecology, natural history, sauria, taxonomy

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Introduction

There are eighteen species of agamid lizards in Sri Lanka, fifteen of which (83.3%) are endemic to the island (Somaweera and Somaweera 2009; Manamendra-Arachchi et al. 2006). Seven of these species belong to the genus *Calotes*, and five of which are endemic (*C. ceylonensis* Müller, 1887; *C. liocephalus* Günther, 1872; *C. liolepis* Boulenger, 1885; *C. nigrilabris* Peters, 1860; *C. desilvai* Bahir and Maduwage, 2005) (De Silva 2006). The remaining two *Calotes* (*C. calotes* Linnaeus, 1758 and *C. versicolor* Daudin, 1802) are probably widespread throughout Southeast Asia. According to published literature, the endemic *Calotes nigrilabris* is a largely arboreal species found only in montane and submontane cloud forests above 1,400 m elevation (Das and De Silva 2005; Manamendra-Arachchi and Liyanage 1994). Its conservation status is rare and vulnerable (Manamendra-Arachchi and Liyanage 1994; IUCNSL and MENR 2007). However, Deraniyagala (1953) had reported a specimen from Peradeniya (~650 m a.s.l.), at a much lower elevation than other known localities. Here we redescribe this poorly known species based on the holotype and newly collected specimens to provide more detailed taxonomic information and proper identification of species in this genus. This information is compiled into a diagnostic key for the Sri Lankan members of the genus *Calotes*. Little ecological information is available for this species, and further studies of its behavior and ecology may be important for its conservation.

Methods and materials

The material examined is deposited at the NHMW, Naturhistorisches Museum of Vienna, Vienna, Austria and Wildlife Heritage Trust of Sri Lanka (WHT), Colombo, Sri Lanka. Diagnoses and descriptions are based on external morphology. The locality records for each specimen include WHT specimen data, published locality records as well as our observations during the past decade (Fig. 1). All photographs and line drawings are displayed with the photographer and artist initials: A. Schumacher (AS), Thasun Amarasinghe (TA), Majintha Madawala (MM), Gayan Pradeep (GP), and Vimukthi Weeratunge (VW).

All measurements were taken to the nearest 0.1 mm with dial calipers (Table 1). Scale counts: SUP, supralabials were counted from the first scale anterior to that at angle of gape, not including the median scale (when present); INF, infralabials were counted from first scale posterior to mental, to angle of gape; DS, dorsal spines were counted from first spine to last of mid-dorsal row; CR, canthus rostralis were counted scales from rostral scale along scale row passing over nostril to posterior

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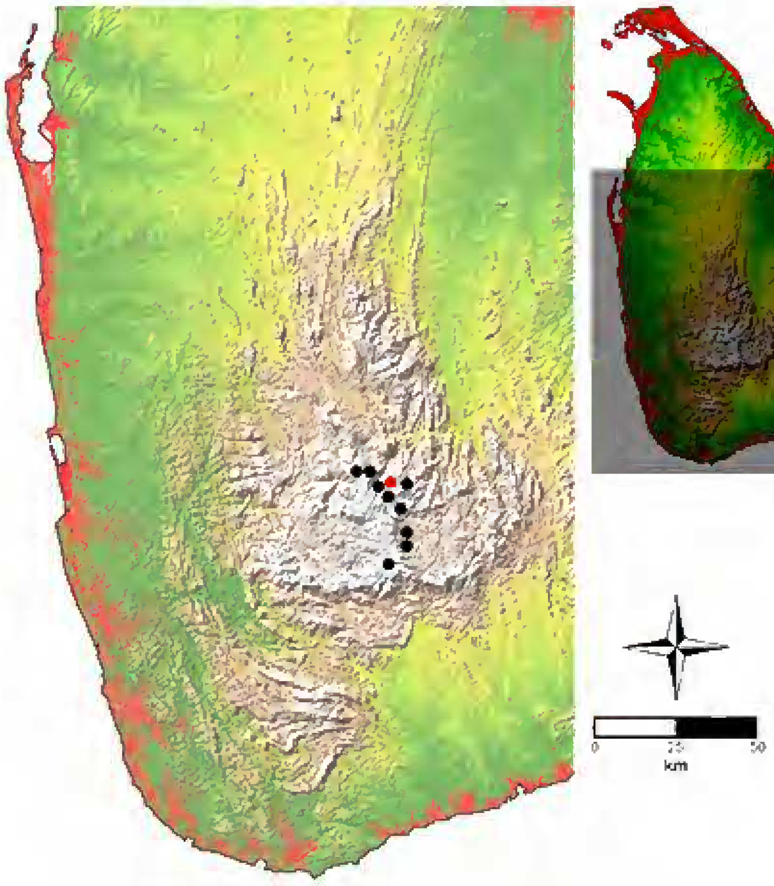

Figure 1. Current distribution patterns of *C. nigrilabris* (central highland of Sri Lanka) (red circle: type locality and black circle: other sightings).

end of supraciliary ridge; MDS, mid-dorsal scales were counted from scale behind rostral to posterior margin of the thigh; MBS, mid-body scales were counted from center of mid-dorsal row forwards and downwards across ventrals (this count is, however, made unreliable by the unequal size and uneven arrangement of the lateral scales); MVS, mid-ventral scales were counted from first scale posterior to mental, to last scale anterior to vent; SAT, spines around tympanum were counted from first spine to last above tympanum. External measurements: SVL, snout-vent length (distance between tip of snout to anterior margin of vent); HL, head length (distance between posterior edge of mandible and tip of snout); HW, head width (maximum width of head); DHL, dorsal head length (distance between posterior edge of cephalic bone and tip of snout); NFE, nostril-front eye length (distance between anterior most point of orbit and middle of nostril); UAL, upper-arm length (distance between axilla and angle of elbow); LAL, lower-arm length (distance from elbow to wrist with both upper arm and palm flexed); FL, finger length (distance between tip of claw and the nearest fork); FEL, femur length (distance between groin and knee); TBL, tibia length (distance between knee and heel, with both tibia and tarsus flexed); TL, toe length (distance between tip of claw and nearest fork); AG, axilla-groin length (distance between axilla and groin); SA, snout-axilla length (distance between tip of snout and axilla); TAL, tail length (measured from anterior margin of vent to tail tip); PAL, palm length (taken from posterior most margin of palm and tip of longest finger); FOL, foot length (distance between heel and tip of longest toe, with both foot and tibia flexed); TBW, width of tail base (greatest distance across the tail base); IOW, inter orbital width (least distance between the upper margins of orbits); ED, eye diameter (horizontal diameter of orbit); SFE, snout-front eye length (distance between anterior most point of orbit and tip of snout); SBE, snout-back eye length (distance between posterior most point of orbit and tip of snout); SFT, snout-front tympanum length (distance between anterior most point of tympanum and tip of snout); TD, tympanum diameter (least distance between the inner margins of tympanum).

Calotes nigrilabris Peters, 1860

Peters, W. C. H., *Monatsberichte der Königlichen Akademie der Wissenschaften zu Berlin*, 1860: 183.

English Name: Ceylon black-cheek lizard or Dark-lipped lizard; Sinhala Name: Kalü-kopül Katüssä or Kalü-deküpül Katüssä.

Holotype: Male (99.8 mm SVL); Cat. no. NHMW 23355; Loc. Newera Ellia: Ceylon (=Nuwara Eliya: Sri Lanka); Coll. Unknown; Date. Unknown (see Amarasinghe et al. 2009 and Tiedemann et al. 1994; Fig. 2).

Other materials examined: WHT 0380A, WHT 0380B, WHT 0380C, WHT 0380D, Nagrak Division, Nonpareil Estate, Horton Plains (06°46’ N 80°47’ E, 2135 m); WHT 0379, Kuda Oya, Labugolla (07°01’ N 80°44’ E, 1670 m); WHT 1555, WHT 2262, WHT 0536, Hakgala (06°55’ N 80°49’ E, 1830 m).

Diagnosis

A row of 4, 5, or 6 laterally compressed spines above the tympanum; lateral scales on the body directed backwards and downwards; dorsal and lateral scales on the body much smaller than the ventral scales on the chest and abdomen.

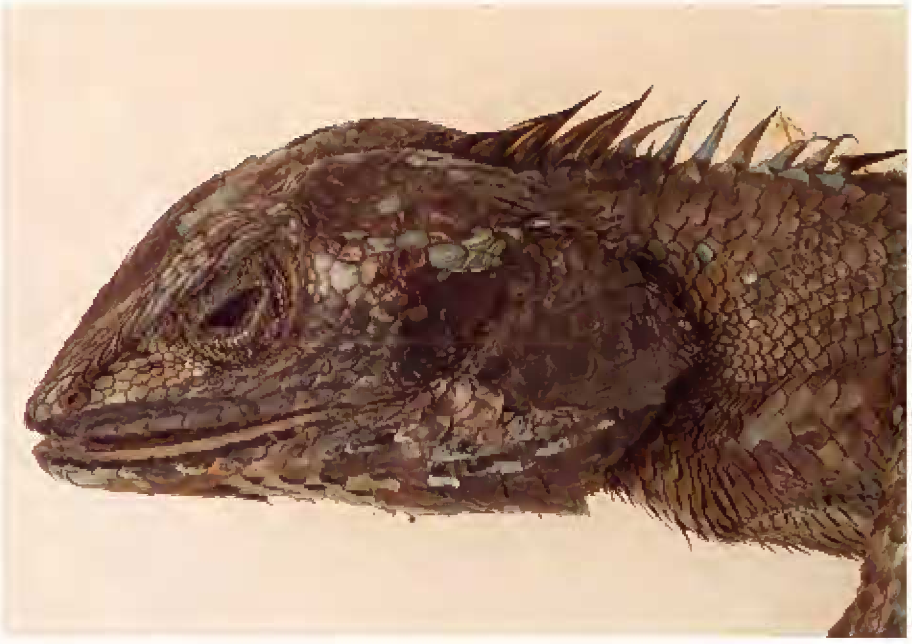

Figure 2. Dorsolateral view: holotype *C. nigrilabris* (Male) (NHMW 23355) Nuwara Eliya, Sri Lanka (AS).

Key to Sri Lankan species of genus *Calotes*

1. No spines above the tympanum and lateral scales on the body pointing backwards and downwards .... *Calotes liocephalus*
Spines above the tympanum present 2

2. Dorsal crest absent or less developed .... *Calotes ceylonensis*
Dorsal crest present and well developed 3

3. A row of laterally compressed spines above tympanum 4
Two separated spines above tympanum 5

4. Ventral scales larger than dorsal scales and scales on sides pointing backwards and downwards .... *Calotes nigrilabris*
Ventral scales not larger than dorsal scales and scales on sides pointing backwards and upwards .... *Calotes calotes*

5. Scales on sides pointing backwards and upwards .... *Calotes versicolor*
Scales on sides pointing backwards and downward 6

6. Gular sac present with black bands .... *Calotes desilvai*
Gular sac present without black bands .... *Calotes liolepis*

Description

(Based on the holotype and WHT collection). Length of head one and half times its width; snout slightly longer than orbit; rostral small, nasal rather large, forehead concave; cheeks swollen in the adult male; upper head scales unequal, smooth; 8 to 10 scales in canthal row, canthus rostralis and supraciliary edge sharp; a row (3-6 spines) of laterally compressed spines starting from above the tympanum and extending posteriorly beyond it; diameter of tympanum about half that of the orbit. Supralabials, 9-11; infralabials, VIII-IX (Fig. 3). Body laterally compressed; dorsal scales more or less distinctly keeled, pointing backwards and downwards (Fig. 4), except the upper two or three rows with scales smaller than the ventrals, pointing directly backwards, strongly keeled, and mucronate. Gular sac not developed, gular scales keeled, as large as the ventrals; a short oblique pit or fold in front of the shoulder covered with small granular scales. Nuchal and dorsal crests continuous, moderately developed, composed of 17-27 lanceolate spines gradually diminishing in size; the longest spines on the neck do not equal the diameter of the orbit; female with a lower crest and a mere ridge posteriorly. Limbs moderate; third and fourth fingers equal or fourth finger a little longer than the third. Relative length of fingers: 1<5<2<4<3 or 1<5<2<3<4. Forth toe distinctly longer than the third. Relative length of toes: 1<2<5<3<4. The hind limb reaches to the orbit or the temple. Tail long and slender; in the adult male it is markedly swollen at the base, with large, thick, keeled scales.

Color pattern

(Based on our observations of live specimen; not collected). The body color is green with whitish, black-edged, transverse bars or spots. Head marked with black; upper lips and cheeks usually with a black streak or separated from the eye by a white streak or with a pale bluish-green stripe running from ear to shoulder; underside of the head greenish-white, sometimes reddish-brown vertebral band present or absent; base of the tail dark olive or brown with darker-bordered light band or spots (Fig. 5).

Distribution and habitat

Calotes nigrilabris is endemic to Sri Lanka and had only been recorded from montane and submontane cloud forests above 1,400 m elevation in the central highlands. However, examination of additional specimens reveals that *Calotes nigrilabris* also occurs in the Horton Plains (Kirigalpotta, ~2200 m), which are grasslands around Nuwara Eliya, Hakgala. Thus, *C. nigrilabris* is the only *Calotes* species to occur in tropical high altitude open grasslands (Bahir and Surasinghe 2005). According to our observations *C. nigrilabris* is recorded from: Horton Plains National Park (06°46’ N 80°47’ E, ele. 2130 m); Kuda Oya, Labugolla (07°01’ N 80°44’ E, ele. 1670 m); Hakgala (06°55’ N 80°49’ E, ele. 1830 m); Nuwara Eliya (06°57’ N 80°47’ E, ele. 1710 m); Piduruthalagala (06°59’ N 80°46’ E, ele. 2300 m); Labukele (07°01’ N 80°42’ E, ele. 1525 m); Pattipola (06°51’ N 80°50’ E,

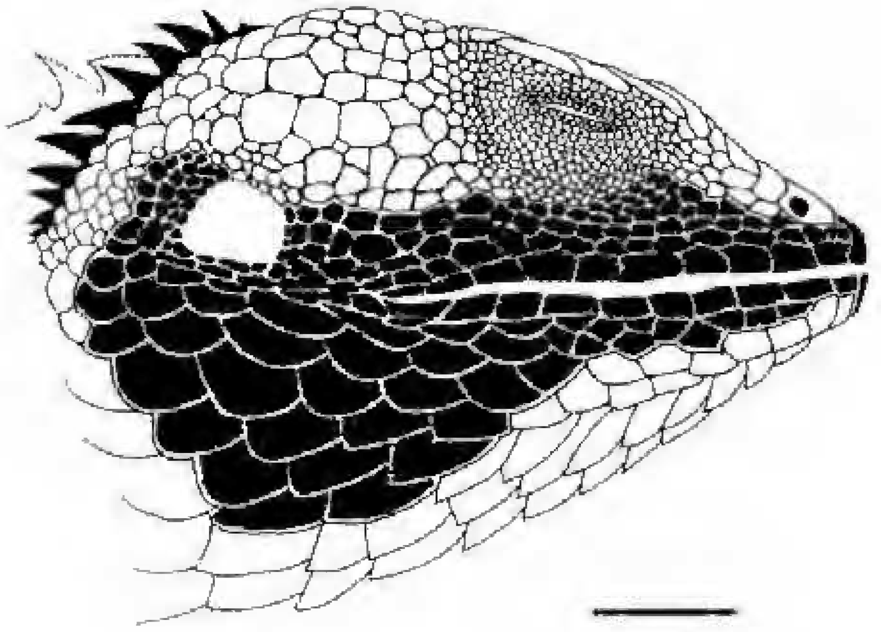

Figure 3. Lateral side view (head scalation): male *C. nigrilabris* (WHT 2262) Hakgala, Sri Lanka (Scale bar = 10 mm) (TA).

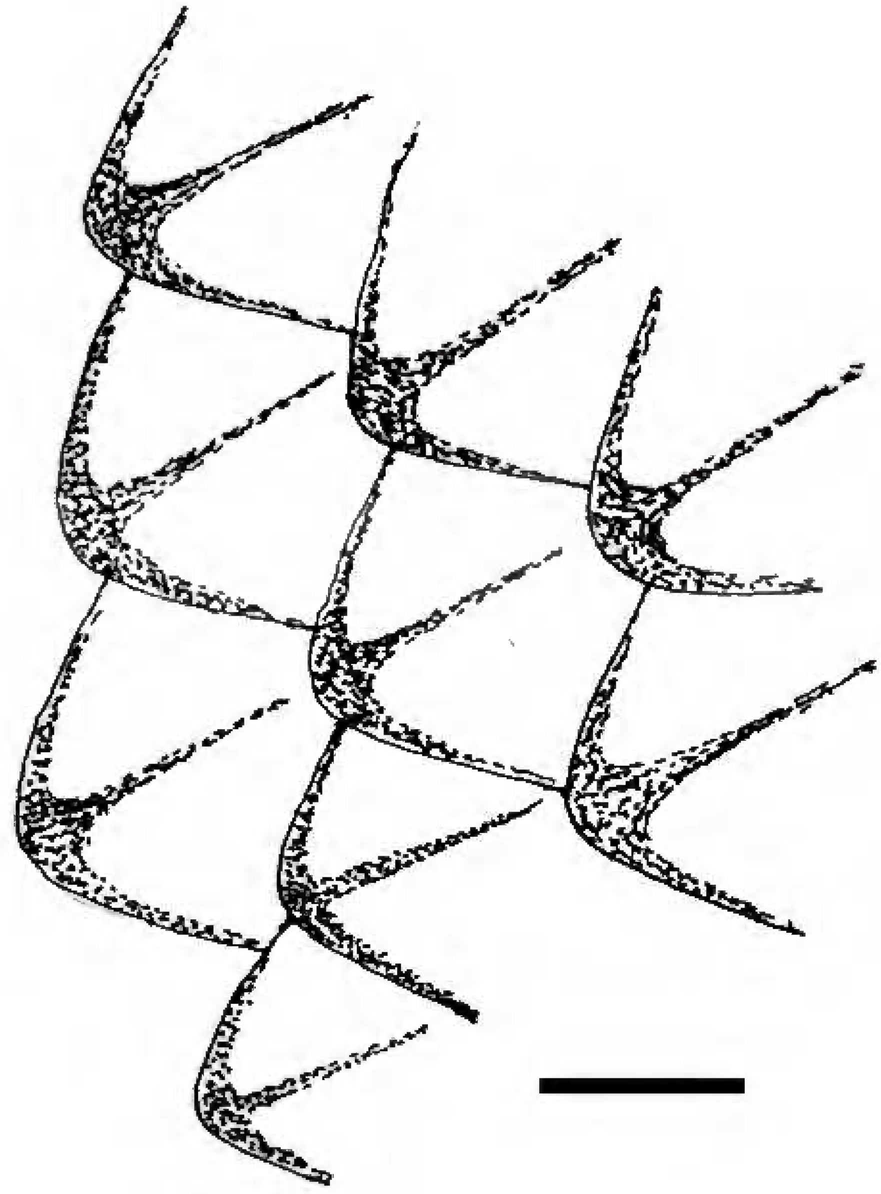

Figure 4. Mid body lateral scales pointing backwards and downwards of the male *C. nigrilabris* (WHT 0379) Labugolla, Sri Lanka (Scale bar = 1 mm) (TA).

ele. 1890 m); Ohiya (06°49' N 80°50' E, ele. 1800 m); Kandapola (06°59' N 80°50' E, ele. 1920 m); and Ragala (06°59' N 80°47' E, ele. 1980 m).

Although the Dumbara population of *Calotes nigrilabris* has long been recognized (Deraniyagala 1953), it has not been compared critically with the populations of the Central Hills. Unfortunately, the specimens from Gammaduwa in the Dumbara Hills, deposited by Deraniyagala in the National Museum of Sri Lanka, Colombo, have since been lost. However, Erdelen (1984) mentioned that he had no evidence of this species from the Knuckles, in contrast to Deraniyagala (1953). Nevertheless, we located *C. nigrilabris* from Thangappuwa (~1000 m a.s.l.) in the Knuckles Region in 2003 and observed two individuals (SVL 139.4 mm and 140.1 mm). In ongoing research, we are working to clarify whether these two populations are separate species.

Hemipenis morphology

There has been no serious attempt to classify agamid lizards based on the morphological characters of the hemipenis, even though there is an enormous diversity in hemipenal morphology. The hemipenis of *C. nigrilabris* seems less differentiated as compared to *C. ceylonensis* (Karunarathna et al. 2009) and *C. liocephalus* (Amarasinghe et al. 2009). The hemipenis of *Calotes nigrilabris* is well developed. The pedicel is slightly shorter than the head; below the head, it is broadened out into two shallowly concaved shoulders; there are no spines. The head is quadrangular in shape. It is shallowly divided longitudinally into four lobes, two being slightly larger than the others. The surface of the head is pitted in a reticulating pattern, the pits being larger on the outside and diminishing in size towards the divisions between the lobes (Fig. 6).

Reproduction

The female digs a nest hole in the ground and deposits two eggs in December (Deraniyagala 1953) and Taylor (1953) observed two ova in each oviduct and the eggs were 23 mm × 13 mm in size. We observed oviposition at Horton Plains National Park in March 2010. The female laid three eggs in the nest hole; sizes of the eggs were 17.5 mm × 10.1 mm, 17.8 mm × 10.8 mm, and 19.5 mm × 10.2 mm (average size: 18.3 mm × 10.4 mm). In September 2001, we observed another female ovipositioning at Nuwara Eliya. That female also laid three eggs; sizes of the eggs were 17.4 mm × 9.8 mm, 17.0 mm × 9.7 mm, and 17.1 mm × 9.7 mm (average size: 17.2 mm × 9.7 mm). A recent paper by Karunarathna et al. (2011) states that female *C. nigrilabris* deposit 2-4 eggs at a time.

We have successfully hatched eggs in captivity. Eggs were buried under soil in a screen-topped glass enclosure. The above four eggs were half-buried in soil and covered with leaf litter. The length of the enclosure measured 300 mm, width 150 mm, and height 100 mm. The container holding the eggs was placed in a dark and cool place (temperatures approximately 27.2-28.5°C day time and 25.7-26.4°C night). The relative humidity ranged from 62%-78% during incubation. The surface soil was generally kept dry, but occasionally about 50 ml of tap water was sprayed in the hatching enclosure to maintain a cool, humid environment similar to the original habitat.

Table 1. Measurements (mm) and counts of the male holotype (NHMW 23355), three additional males, and five females of *Calotes nigrilabris* (see measured material for specimen data).

Males (*n*=4)	NHMW 23355	WHT 0380C	WHT 1555	WHT 2262	Range	Mean ± SD
SVL	99.8	87.9	84.3	91.8	84.3–99.8	90.9 ± 5.8
HL	34.1	34.0	31.9	33.6	31.9–34.1	33.4 ± 0.9
HW	20.4	23.0	22.1	22.7	20.4–23.0	22.0 ± 1.0
DHL	25.7	25.0	26.0	24.4	24.4–26.0	25.3 ± 0.6
NFE	6.8	7.8	9.8	6.0	6.0–9.8	7.6 ± 1.4
UAL	19.1	25.8	21.7	25.5	19.1–25.8	23.0 ± 2.8
LAL	22.0	17.7	17.2	19.9	17.2–22.0	19.2 ± 1.9
FL I	5.5	5.3	4.4	7.1	4.4–7.1	5.6 ± 1.0
FL II	9.1	10.0	8.6	11.6	8.6–11.6	9.8 ± 1.1
FL III	14.7	15.1	10.2	15.8	10.2–15.8	13.9 ± 2.2
FL IV	14.4	13.9	12.4	15.9	12.4–15.9	14.1 ± 1.3
FL V	8.1	9.1	7.1	9.4	7.1–9.4	8.4 ± 0.9
FEL	23.2	28.7	23.3	29.6	23.2–29.6	26.2 ± 3.0
TBL	25.4	23.5	20.5	23.8	20.5–25.4	23.3 ± 1.8
TL I	6.5	10.5	5.6	8.2	5.6–10.5	7.7 ± 1.9
TL II	10.6	10.9	8.0	13.2	8.0–13.2	10.7 ± 1.8
TL III	17.0	12.1	15.0	18.5	12.1–18.5	15.6 ± 2.4
TL IV	20.8	14.4	16.7	21.7	14.4–21.7	18.4 ± 3.0
TL V	14.5	13.5	10.8	15.5	10.8–15.5	13.6 ± 1.8
AG	46.8	42.5	39.3	44.7	39.3–46.8	43.3 ± 2.8
SA	43.8	43.5	36.8	41.7	36.8–43.8	41.4 ± 2.8
TAL	285.7	225.0	broken	283	225.0–285.7	264.6 ± 28.0
PAL	22.1	23.2	15.1	19.9	15.1–23.2	20.1 ± 3.1
FOL	35.8	33.1	21.3	34.2	21.3–35.8	31.1 ± 5.7
TBW	10.5	11.1	10.7	12.0	10.5–12.0	11.1 ± 0.6
IOW	4.6	4.0	4.8	4.4	4.0–4.8	4.4 ± 0.3
ED	8.4	7.0	8.6	8.3	7.0–8.6	8.1 ± 0.6
SFE	11.6	8.0	10.8	10.1	8.0–11.6	10.1 ± 1.3
SBE	18.6	18.0	19.7	18.9	18.0–19.7	18.8 ± 0.6
SFT	25.4	24.8	24.6	24.2	24.2–25.4	24.7 ± 0.4
TD	3.5	6.0	3.7	5.4	3.5–6.0	4.6 ± 1.1
SUP	10	10	9	9	9–10	9.5 ± 0.5
INF	10	9	9	8	8–10	9.0 ± 0.7
MDS	65	59	66	63	59–66	63.3 ± 2.7
CR	10	10	10	9	9–10	9.8 ± 0.4
MBS	50	49	58	48	48–58	51.3 ± 4.0
MVS	57	56	103	53	53–103	67.3 ± 20.7

Table 1 continued.

Females (n=5)	WHT 0380A	WHT 0380B	WHT 0380D	WHT 0379	WHT 0536	Range	Mean ± SD
SVL	71.0	71.8	74.9	77.3	70.7	70.7–77.3	73.1 ± 2.6
HL	24.1	24.4	24.8	23.9	22.6	22.6–24.8	24.0 ± 0.7
HW	14.1	14.1	13.5	13.6	13.4	13.4–14.1	13.7 ± 0.3
DHL	19.1	18.5	19.5	19.4	18.3	18.3–19.5	19.0 ± 0.5
NFE	5.2	5.2	6.4	5.8	4.7	4.7–6.4	5.5 ± 0.6
UAL	19.8	19.1	20.3	21.8	20.6	19.1–21.8	20.3 ± 0.9
LAL	17.3	14.7	17.2	15.8	15.3	15.3–17.3	16.1 ± 1.0
FL I	6.5	6.3	5.4	6.9	6.0	5.4–6.9	6.2 ± 0.5
FL II	10.0	10.6	7.6	9.4	10.1	7.6–10.6	9.5 ±1.0
FL III	12.6	14.3	10.1	12.7	12.6	10.1–14.3	12.5 ± 1.3
FL IV	11.9	13.9	10.8	11.8	11.6	10.8–11.9	12 ± 1.0
FL V	8.8	8.5	7.8	7.9	8.0	7.8–8.8	8.2 ± 0.4
FEL	25.1	24.7	23.6	25.6	22.7	22.7–25.6	24.3 ± 1.1
TBL	19.3	18.7	18.8	20.1	18.9	18.7–20.1	19.2 ± 0.5
TL I	5.8	6.8	4.6	6.0	5.5	4.6–6.8	5.7 ± 0.7
TL II	8.5	10.8	7.7	8.8	8.1	7.7–10.8	8.8 ± 1.1
TL III	14.2	14.7	12.9	16.0	13.2	12.9–16.0	14.2 ± 1.1
TL IV	17.7	19.1	21.7	18.1	16.1	16.1–21.7	18.5 ± 1.9
TL V	12.4	13.1	9.6	12.0	12.0	9.6–13.1	11.8 ± 1.2
AG	35.6	34.8	37.1	38.6	35.9	34.8–38.6	36.4 ± 1.3
SA	34.8	33.7	33.2	33.7	29.6	29.6–34.8	33.0 ± 1.8
TAL	205	225	270	247	225	205–270	234.4 ± 22.2
PAL	16.7	15.6	13.8	15.6	18.7	13.8–18.7	16.1 ± 1.6
FOL	26.6	30.7	20.7	28.0	26.6	20.7–30.7	26.5 ± 3.3
TBW	6.8	9.1	7.4	8.4	6.8	6.8–9.1	7.7 ± 0.9
IOW	3.5	3.2	2.4	3.4	3.8	2.4–3.8	3.3 ± 0.5
ED	6.3	6.5	7.5	6.5	7.5	6.3–7.5	6.9 ± 0.5
SFE	8.8	7.8	9.9	8.8	8.8	7.8–9.9	8.8 ± 0.7
SBE	15.4	15.1	16.8	15.4	15.6	15.1–16.8	15.7 ± 0.6
SFT	19.2	19.0	19.8	18.7	18.4	18.4–19.8	19.0 ± 0.5
TD	3.8	3.7	3.4	3.6	3.6	3.4–3.8	3.6 ± 0.1
SUP	10	11	10	9	9	9–11	9.8 ± 0.7
INF	9	8	9	9	9	8–9	8.8 ± 0.4
MDS	59	64	62	59	71	59–71	48.8 ± 7.3
CR	9	10	8	8	10	8–10	9.0 ± 0.9
MBS	51	53	48	53	47	47–53	50.4 ± 2.5
MVS	61	64	57	61	51	51–64	58.8 ± 4.5
DS	24	23	21	19	17	17–24	20.8 ± 2.6
SAT	5	5	4	4	4	4–5	4.4 ± 0.5

Figure 5. Mature male *C. nigrilabris* (Nuwara Eliya) (black patch shown in cheek and small gular sac) (VW).

The lid of the container was close-fitting to deter predators (ants, etc.) and occasionally opened to spray water.

The juveniles emerged after 69 days. The emerging hatchings waited approximately one hour, with snouts extended from their shells, before rapidly exiting the egg. The newly emerged juveniles ranged from 48.1-53.6 mm in SVL and 2.5-3.2 g in weight (Table 2). After emerging from their eggs, they were very active, running in circles around the tank 10-15 times. We regularly provided small earthworms, juvenile cockroaches, and termites. During their first two days, these hatchlings only fed on earthworms and ate after breaking the prey into small parts. On the third day, these animals refused earthworms and only feed on juvenile cockroaches. They never fed on termites. Each individual ate 5-8 juvenile cockroaches per day. After approximately 10 days, the hatchlings were released in good condition to the original habitat.

Table 2. Measurements (mm) and weight (WT) in grams of hatchling *Calotes nigrilabris* in captivity (CH: Character).

CH	(1)	(2)	(3)	(4)	Range	Mean ± SD
SVL	49.7	48.1	51.3	53.6	48.1-53.6	50.7 ± 2.0
HL	11.2	12.1	11.6	11.9	11.2-12.1	11.7 ± 0.3
AG	28.6	29.6	28.9	30.1	28.6-30.1	29.3 ± 0.6
WT	2.6	2.8	2.5	3.2	2.5-3.2	2.8 ± 0.3

Behavior

Fernando (1998) mentioned that male *C. nigrilabris* gave a short hiss when handled. We also noted this hissing several times while handling this species. It is a very

Figure 6. Left hemipenis (lateral aspect) in *C. nigrilabris* (WHT 1555) (TA).

Figure 7. Female *C. nigrilabris* on a *Rhododendron arboretum* bush (Horton Plains NP) (GP).

short, unrepeated "chik" sound, and it was only produced by males.

Hatchlings are mostly found on bushes of *Cymbopogon* sp., *Panicum* sp., *Ulex europaeus*, and *Strobilanthes* sp. and are typically light green. When disturbed or danger approaches, these hatchlings take cover in an adjacent bush. Mature individuals typically lie on endemic *Rhododendron arboreum* shrubs and when disturbed, or danger approaches, quickly jump into a nearby *Cymbopogon* sp., *Panicum* sp., *Strobilanthes* sp., or *Ulex europaeus* for refuge. This agamid lizard is usually sub-arboreal and inhabits tree trunks, hedges, and shrubs (Fig. 7) where it hunts insects and earthworms by day (Das and De Silva 2005).

Males are highly territorial and we observed territorial fighting many times on tree trunks (Horton Plains NP, Seetha Eliya, Pattipola, Agarapatana, Nuwara Eliya, Labukele, Haggala, and Ramboda). We never observed the appalling, struggling, and chasing stages of combat described by Karunarathna and Amarasinghe (2008). During the "savaging stage," they bite both fore and hind limbs, cheeks, and nuchal crest of each other. They never chased each other around the trunk while "savaging." Most often, they fight in open areas and the defeated individual jumps down from the tree and escapes.

Conservation status

According to Erdelen (1988), the average population density of *C. nigrilabris* was 220 individuals per hectare in Nuwara Eliya, and the population sizes and percentages of males, females, and juveniles were mostly stable in Nuwara Eliya. According to Karunarathna et al. (2011), the populations of *C. nigrilabris* are declining. The official conservation status of the species is Vulnerable (IUCNSL and MENR 2007).

Discussion

The threats to *C. nigrilabris* appear to stem largely from habitat fragmentation. The impact of fragmentation could be exacerbated by the fact that many important

Figure 8. Typical forest and shrub habitat of *C. nigrilabris* (Horton Plains NP) (GP).

montane forest fragments are surrounded by agricultural plantations (Fig. 8). Additionally, vegetable cultivation in Sri Lanka involves the intensive and indiscriminate application of pesticides (Erdelen 1984; Bahir and Surasinghe 2005). These fast-moving lizards are susceptible to mortality on roads (Fig. 9), and many hydropower projects and rapid urbanization are continuing to modify and fragment forest habitats. Additionally, *C. nigrilabris* has a number of predators, including the Sri Lanka whistling thrush (*Myophonus blighi*), Jungle crows (*Corvus macrorhynchos*), Greater coucal (*Centropus sinensis*), and feral cats (*Felis catus*), which were all recorded in our study areas (Karunarathna and Amarasinghe 2008; De Silva 2006; Warakagoda 1997). The crows are problematic because the local visitors to Horton Plains National Park leave their garbage, which has encouraged the migration and permanent settlement of Jungle crows in Horton Plains NP. Therefore, these crows are a threat for endemic *C. nigrilabris*, as well as other local reptiles.

The ecological and behavioral status of *C. nigrilabris* has been previously investigated by Erdelen (1978, 1984, 1988), who focused on population dynamics and distribution of the genus *Calotes* in Sri Lanka, and by Manamendra-Arachchi and Liyanage (1994), who discussed the zoogeography of the Sri Lankan agamids. The complete ovipositional behaviors of *Calotes calotes* (Gabadage et al. 2009), *Calotes versicolor* (Amarasinghe and Karunarathna 2007), *Calotes nigrilabris* (Karunarathna et al. 2011), *Calotes liocephalus* (Amarasinghe and Karunarathna 2008), *Calotes ceylonensis* (Pradeep and Amarasinghe 2009), and *Calotes liolepis* (Karunarathna et al. 2009) are documented. However, ovipositional data is lacking for *C. desilvai*.

According to Manamendra-Arachchi et al. (2006), the lowlands (elevation ~500 m) of the Mahaweli River, which separates the Dumbara Hills (= Knuckles Hills) from the Central Mountains, appears to have served as a barrier to the dispersal of highland species between the two mountain ranges. Therefore, genetic surveys of these morphologically-defined populations are needed to identify their evolutionary histories. If the Knuckles

Figure 9. Road killed sub-adult female *C. nigrilabris* (Horton Plains NP) (MM).

population is a distinct species, then that species could be critically endangered due to habitat fragmentation by Cardamom (*Elettaria cardamomum*) and tea (*Camellia sinensis*) cultivations, which also often involve the intensive and indiscriminate application of pesticides. Conservation breeding programs may be needed if the population sizes of the species continue to decline in its natural habitat.

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